Discovery of Polycyclic Aromatic Hydrocarbon Ions in NGC 1333

Gregory Sloan, Lou Allamandola, Jesse Bregman, Doug Hudgins, Tom Hayward, Becky Devito

Since the discovery of unidentified infrared emission bands in 1973, their origin has been assigned to several different carriers. Although the first suggestion that these bands were due to polycyclic aromatic hydrocarbons (PAHs) occurred in 1984, the lack of a good match between laboratory spectra of PAHs and the interstellar features prevented a conclusive identification. The large discrepancy between the relative band intensities observed in the laboratory and those observed in astronomical sources has recently been resolved by laboratory spectra of ionized PAHs. Specifically, the relative strengths of the emission features due to C-H bending modes (8.6 and 11.3 microns) are too strong relative to the C-C modes (6.2 and 7.7 microns) in laboratory spectra of neutral PAHs, but ionized PAHs provide a good match with astronomical spectra. The laboratory spectra of ionized PAHs show an additional weak band near 10 microns; they also show that the 11.3-micron band is shifted to shorter wavelengths by 3%–5%.

The reflection nebula in NGC 1333 around the young star SVS 3 has proven to be a fertile region in which to investigate the possible ionization of PAHs. SVS 3 is an early B star, so its ultraviolet output is weaker and cooler than it is in most other PAH sources (e.g., the Orion Bar, NGC 7027), where the PAHs may be completely ionized. Previous observations at coarse spatial resolution had shown that the mid-infrared spectrum changed with position in NGC 1333 in a way consistent with there being a larger fraction of ionized PAHs close to the central star rather than farther away. In order to investigate the spectral variations in the PAH emission at higher spatial resolution, a long-slit spectra of NGC 1333 SVS 3 was obtained at the 5-meter Hale Telescope at Palomar using SpectroCam-10. The slit was oriented N/S and covered a 2- by 16-arcsecond region of the sky covering SVS 3 and the nebulosity to the south.

The combination of high spatial and spectral resolution in the present data set reveals several variations in the shape of the emission features in the 10–13-micron region. The 11.2-micron PAH feature develops a wing on the short-wavelength side close to SVS 3 accompanied by an emission feature at 10 microns. The wavelength of the wing is shifted from the center of the 11.2-micron band by about 4%, just the shift expected for the 11.2-micron feature between neutral and ionized PAHs. As the distance from SVS 3 increases, and as the intensity of the ionizing radiation decreases, both the 10-micron component and the 11.0-micron wing first decrease in strength and then vanish within a few arcseconds. Combining this spatial behavior with the match to features in laboratory spectra of ionized PAHs, it is concluded that both the 10-micron feature and the blue wing of the 11.2-micron feature arise from PAH cations in the nebulosity close to the central star. Specific emission features from ionized PAHs have not been identified before, even though previous spectra of PAH sources show the 10-micron feature.

***Point of Contact:* J. Bregman**
(650) 604-6136
jbregman@mail.arc.nasa.gov